PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 3 : F22B 1/02	A1	(11) International Publication Number: WO 85/ 00419 (43) International Publication Date: 31 January 1985 (31.01.85)

(21) International Application Number: PCT/US84/01044

(22) International Filing Date: 2 July 1984 (02.07.84)

(31) Priority Application Number: 510,314

(32) Priority Date: 1 July 1983 (01.07.83)

(33) Priority Country: US

(71) Applicant: NATIONAL MOTORS CONVERSION CORP. [US/US]; 1007 N. Elsworth Ave., Villa Park, IL 60181 (US).

(71)(72) Applicants and Inventors: FENTON, Ronald, L. [US/US]; Brookwood Towers, Apt. 1208, 465 Dominion Drive, Wooddale, IL 60191 (US). SAMES, William, C. [US/US]; 37W545 Mills Court, St. Charles, IL 60174 (US).

(74) Agent: WHITE, Douglas, B.; Vigil, Meroni & White, 1501 Woodfield Road, Suite 202 North, Schaumburg, IL 60195 (US).

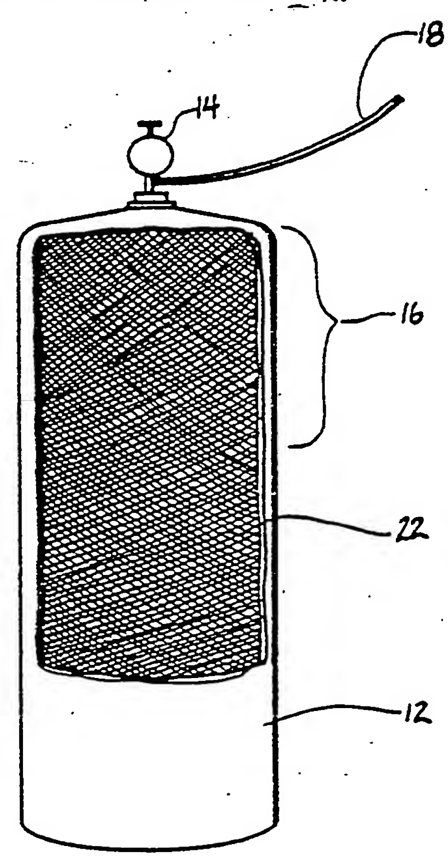
(81) Designated States: AT (European patent), AU, BE (European patent), BR, CF (OAPI patent), CG (OAPI patent), CH (European patent), CM (OAPI patent), DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB (European patent), HU, JP, KP, LK, LU (European patent), MC, MG, MR (OAPI patent), MW, NL (European patent), NO, RO, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent).

Published
With international search report.

(54) Title: IMPROVED FUEL TANK VAPORIZATION APPARATUS AND METHOD

(57) Abstract

An apparatus and heating method for vaporizing liquid fuel within a tank (12) whereby the heat of vaporization is supplied from the ambient environment by utilizing a metallic foil tank insert (22) in heat conductive contact with the tank and the liquid fuel. This insert (22) is preferably a lattice of metal foil rolled to substantially occupy the tank volume and allowing fuel to circulate within. Vaporized fuel collects in the upper portion (16) of the tank (12) to exit through the valve (14).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	KR	Republic of Corea
AU	Australia	LI	Liechtenstein
BE	Belgium	LK	Sri Lanka
BG	Bulgaria	LU	Luxembourg
BR	Brazil	MC	Monaco
CF	Central African Republic	MG	Madagascar
CG	Congo	MR	Mauritania
CH	Switzerland	MW	Malawi
CM	Cameroon	NL	Netherlands
DE	Germany, Federal Republic of	NO	Norway
DK	Denmark	RO	Romania
FI	Finland	SD	Sudan
FR	France	SE	Sweden
GA	Gabon	SN	Senegal
GB	United Kingdom	SU	Soviet Union
HU	Hungary	TD	Chad
JP	Japan	TG	Togo
KP	Democratic People's Republic of Korea	US	United States of America

Improved Fuel Tank Vaporization Apparatus and Method

BACKGROUND OF THE INVENTION

This invention relates generally to tanks for liquified fuel gas such as propane or liquified petroleum gas (LPG) and methods for increasing the vaporization of the liquid fuel in the tank. In a typical propane or LPG tank there is generally encountered a metallic tank member designed to contain the fuel under pressure having a valve at one end to access the contents thereof. Typically, this tank is filled partially or completely with propane or liquid petroleum gas. This liquid fuel is then vaporized under ambient heat and provides an operating pressure under which the vapor may be withdrawn through the tank valve. As vapor is withdrawn, the remaining liquid vaporizes and in so doing absorbs heat known as the latent heat of vaporization. This causes the temperature of the remaining liquid to decrease, which in turn reduces the ability of the remaining liquid to vaporize. Consequently, the pressure of the system continues to fall as a result of the declining liquid temperature due to withdrawal of the vapor. Since the heat loss due to the vaporization of the liquid must be replaced from the heat in the environment surrounding the container, the tank will exhibit decreased function until the liquid temperature is raised.

In order to supply heat to the liquid to maintain sufficient vaporization, a couple of approaches have been proposed in the prior art. In one such process a conduit is installed within the tank and warm fluid passed therethrough. Heat from the pumped fluid is then conducted to the fuel through the conduit to maintain a functional temperature. In yet another approach described in U. S. Patent 4,106,914 issued to Kun-Ming, a recess is formed in the bottom of the tank and an electric light bulb is placed therein to supply heat. Both of these systems require energy input and both require the use of a heating element in conjunction with a tank. Since these tanks contain an inflammable fuel, any suggestion of heating the tank from an external source raises concerns of safety.

In contrast to the foregoing, in the preferred embodiment of the present invention, there is provided a passive heating method for vaporizing liquid fuel within a tank whereby the heat of vaporization is readily and safely supplied from the ambient environment utilizing a conductive foil insert within the tank, thereby improving pressure and gas flow.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an improved fuel tank and vaporization process which does not require external heat generation.

It is a further object of this invention to provide an improved fuel tank and vaporization process which uses a safe, passive heat conduction method to improve vaporization.

In accordance with the foregoing objectives of this invention there is provided a tank insert comprising heat conductable material positioned in contact with the tank walls and arranged to conduct heat therefrom and through the insert to the liquid therein.

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

Figure 1 is an elevational view cut away of a fuel tank partially filled with fuel.

Figure 2 is a perspective sectional view of the tank of Figure 1.

Figure 2a is a cross sectional view of the tank of Figure 1.

Figure 3 is an elevational view of a preferred embodiment of the tank insert.

While the invention will be described in connection with the preferred embodiment, it will be understood that we do not intend to limit the invention to that embodiment. On the contrary, we intend to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to Figure 1 there is shown a conventional fuel tank of the type usable with the preferred embodiment of the present invention having an outer enclosing member 12, and having affixed to its upper extremity a valve 14 arranged to direct flow of vapor from the upper section 16 of the tank through the conduit 18 for use in consumer or industrial combustion processes. In normal operation liquid stored in the tank vaporizes and accumulates in the upper vapor section 16 whereupon it is withdrawn as needed. In conventional systems the vaporization of the liquid is dependent upon the heat available from the external environment

through the tank wall 12. Under periods of excessive use the temperature of the liquid will be reduced to a point where the vaporization becomes limited. This will in turn limit the amount of vaporized fuel available for consumption.

In accordance with the process of the present invention there is provided within said tank, and particularly within said liquid filled portion of said tank, a heat conductive member 22 arranged to conduct heat from the external wall 12 of the tank member throughout the liquid containing portion of the tank chamber. In the preferred embodiment of the present invention, this insert 22 (see Figure 3) would be formed as a metallic foil lattice shaped sheet rolled to conform to the confines of the tank. In this arrangement the volume of the liquid filled portion of the tank is criss-crossed by numerous metallic foils. While the total volume of the tank is reduced to a small extent, considerable volume is retained by using thin foils in this lattice network.

Technically this process increases the wetted surface of the tank. Generally, the greater the wetted surface of a tank the greater the amount of vaporization capacity of the system. Consequently, a larger container, having a larger wetted surface area, would have a greater vaporizing capacity. By incorporating the process of the present invention, providing the insert described above, an increase in the wetted surface is achieved without changing the size or dimensions of the tank.

In accordance with the above, the following chart and formula show the propane vaporization capacity for tanks not incorporating the insert containing a varying percentage of fuel.

Percentage of Container Filled	K Equals
60	100
50	90
40	80
30	70
20	60
10	45

Propane Vaporization Capacity at 0° Fahrenheit (in BTU/hour) = D x L x K

where D = Outside diameter in inches

L = Overall length in inches

K = Constant for percent volume of liquid in container

This formula allows for the temperature of the liquid to refrigerate to -20° F (below zero), producing a temperature differential of 20° F for the transfer of heat from the air to the container's wetted surface and then into the liquid. The vapor space area of the vessel is not considered since its effect is negligible.

For a standard 100 lb. cylinder the above equation translates to a maximum continuous draw of vapor as shown in the following chart.

VAPORIZATION RATE (100 lb. Propane Cylinders)

Lbs. of Propane in Cylinder	Maximum Continuous Draw in BTU per hour at Various Temperatures (° F)				
	0° F	20° F	40° F	60° F	70° F
100	113,000	167,000	214,000	277,000	300,000
90	104,000	152,000	200,000	247,000	277,000
80	94,000	137,000	180,000	214,000	236,000
70	83,000	122,000	160,000	199,000	214,000
60	75,000	109,000	140,000	176,000	192,000
50	64,000	94,000	125,000	154,000	167,000
40	55,000	79,000	105,000	131,000	141,000
30	45,000	66,000	85,000	107,000	118,000
20	36,000	51,000	68,000	83,000	92,000
10	28,000	38,000	49,000	60,000	66,000

This chart shows the vaporization rate of containers in terms of the temperature of the liquid and the wetted surface area of the container. When the temperature is lower or if the container has less liquid in it, the vaporization rate of the container is reduced.

By utilizing the process of the present invention, improved vapor output is achieved. Tests were performed directly comparing the vapor output from tanks with a 20 lb. LPG capacity and using a starting regulator pressure of 30 psi. Two different vapor flow rates were investigated. The tanks containing the insert exhibited higher regulator pressure throughout the test and produced a larger amount of vapor. In the test, similar Fisher Type 64 regulators were used and the vapor manifold system allowed either

vapor system to be diverted through a flowmeter (Brooks Rotameter Type 1110, Tube R-7M-25-1, Float 37469). Although this flowmeter was not calibrated for LPG vapor, it provided comparative flow rate data.

Similar new torches manufactured by Flame Engineering, Inc., were used and the vapor flow rate was controlled by downstream torch control valves. The tanks were located indoors out of direct sunlight and the temperature of the upper and lower position of the tanks was monitored.

The data for the first test is given in Table I.

TABLE I (Test 1)

	Tank 1-A SN 15062C (Lattice Foil Insert)	Tank 1-B SN 15059C (Standard Tank)
Empty weight (lbs.)	14.75	12.75
Propane (lbs.)	20.00	20.00
Initial weight (lbs.)	34.75	32.75
Final weight (lbs.)	24.50	22.75
Propane used (lbs.)	10.25	10.00
Average BTU/hour *	221,308	215,910

* 21,591 BTU/lb.

The initial pressure of the regulators was 30 psi and the test was terminated in one hour. At the conclusion of the test, the tank containing the insert exhibited a higher regulator pressure (4.6 psi versus 3.2 psi) and a greater amount of fuel was produced (10.25 lbs. versus 10.00 lbs.). The ambient temperature was 78°F throughout the experiment. Initially the flow rate reading was 86.4 for both tanks, but after 50 minutes of testing, the flow rate scale reading was 33 and 31 for the tank containing the insert and the standard tank, respectively. After 30 minutes of testing, the gas regulator pressure was 15 psi and 10 psi for the two tanks, respectively.

Test 2 was performed at a lower flow rate than test 1 and terminated after 3 hours and 40 minutes.

The data for the second test is given in Table II.

TABLE II (Test 2)

	Tank 2-A SN 15063C (Lattice Foil Insert)	Tank 2-B SN 15005C (Standard Tank)
Empty weight (lbs.)	14.75	12.75
Propane (lbs.)	20.00	20.00
Initial weight (lbs.)	34.75	32.75
Final weight (lbs.)	17.00	15.50
Propane used (lbs.)	17.75	17.25
Average BTU/hour *	104,551	101,567

* 21,591 BTU/lb.

The inital pressure of the regulators was 30 psi. At the conclusion of the test, the tank containing the insert exhibited a higher regulator pressure (5.8 psi versus 5.2 psi) and a greater amount of fuel was produced (17.75 lbs. versus 17.25 lbs.).

In summary there has been shown and described an improved apparatus and process for providing a passive heating method for vaporizing liquid fuel within a tank, whereby the heat of vaporization is readily and safely supplied from the ambient environment by utilizing a metallic foil tank insert in the form of a rolled lattice sheet positioned in conductive contact with the tank wall and the liquid fuel, thereby improving pressure and gas flow.

CLAIMS

We claim:

1. An improved tank apparatus for improving vaporization of liquid stored therein comprising:

a closed tank member having a valve arranged on one end thereof for selective access to the contents of said tank;

a heat conductive insert within said tank for transmitting heat by conduction from said tank member to the liquid whereby heat for vaporization is conducted to said liquid.

2. A method for improving vaporization of liquid stored within a tank comprising:

inserting within the tank a heat conducting member for transmitting heat from said tank to the liquid;

storing liquid within the tank;

selectively withdrawing vaporized liquid from the tank.

3. The tank apparatus of Claim 1 wherein said heat conductive insert comprises a metallic foil member.

4. The tank apparatus of Claim 3 wherein said heat conductive insert further comprises a metallic foil lattice member.

5. The tank apparatus of Claim 4 wherein said heat conductive insert comprises a rolled metallic foil lattice sheet.

6. The tank apparatus of Claim 4 wherein said tank insert comprises multiple layers of a metallic foil lattice sheet.

7. The method of Claim 2 further comprising the first step of rolling a metallic foil lattice sheet to form a heat conduction member.

8. The method of Claim 2 further comprising the first step of forming an insert of multiple layers of a metallic foil lattice sheet.

1/1

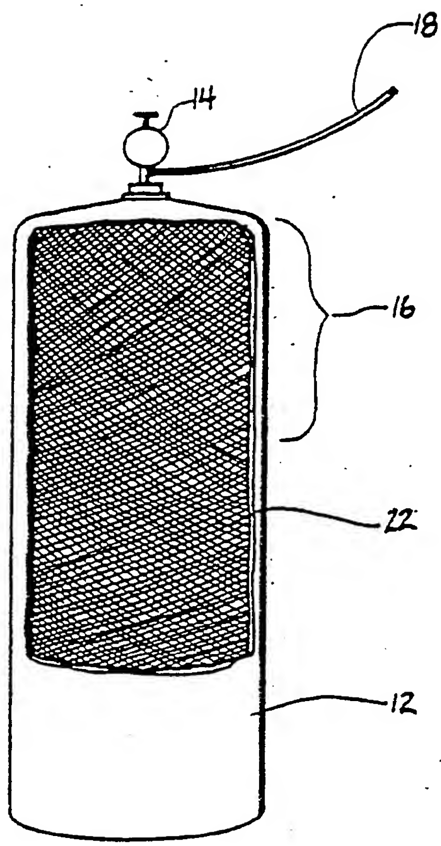


Fig. 1

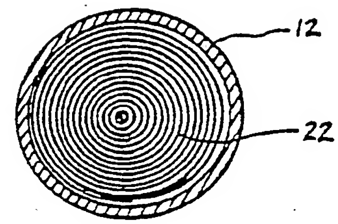


Fig. 2a

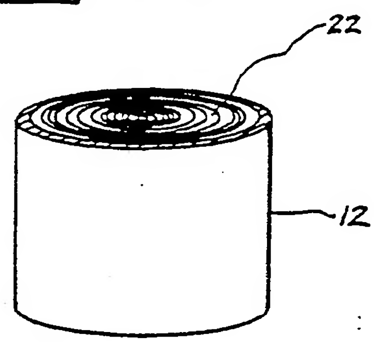


Fig. 2

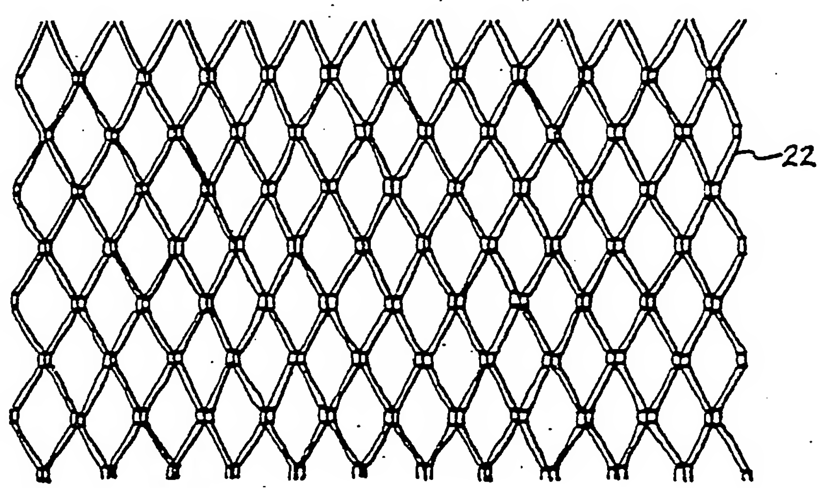


Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 84/01044

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.[3] F22B 1/02
U.S. CL. 122/27

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols	
U.S.	122/27 126/44	431/203, 206, 240 220/88A

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 4,149,649 17 April 1979 (17.04.79) Szego	1-8
Y	US, A, 3,356,256 05 Dec. 1967 (05.12.67) Szego	1-8

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
07 August 1984	14 AUG 1984
International Searching Authority [1]	**Signature of Authorized Officer** [20]
ISA/US	Edward G. Favors Edward G. Favors

Form PCT/ISA/210 (second sheet) (October 1981)